bones buried in the sand of the beaches where so many hundreds of whales have been flensed in former centuries.

In 1878 the accomplished historian of Guipuzcoa, Don Nicolas Soraluce, printed a pamphlet at Vitoria on "the origin and history of the whale and cod fisheries," which contains much interesting information. I may add that Señor Soraluce is preparing some additional chapters on the whale-fishery, and that he expects to obtain copies of interesting documents relating to the same subject from the archives of the Ministry of Marine at Madrid.

A SYSTEM OF METEOROLOGICAL OBSERVATIONS IN THE CHINA SEAS

IN a recent article in NATURE we referred to the proposal to establish an observatory at Hongkong under the superintendence of Major Palmer, R.E., and expressed a hope that Mr. Hart, of the Chinese Maritime Customs, would be successful in his efforts for the establishment of a number of meteorological stations along the coast of China. The China seas, on account of their numerous currents and destructive typhoons, are especially dangerous to shipping, and the value, in a material sense, of a thorough and accurate series of observations of this kind can hardly be overrated. Moved by these considerations, the Shanghai General Chamber of Commerce, the most numerous and influential foreign mercantile body in the Far East, has taken the matter in hand, and at a recent meeting, reported in the *Celestial Empire*, discussed "the feasibility of organising a system of meteorological reports from the China coast and the interior, with the view of improving the knowledge of the origin and direction of storms, and warning mariners of their approach." The Chamber wisely consulted the Reverend Father Dechevrens, director of the Jesuits' Observatory at Siccawei, not far from Shanghai, who recommended that the object of the system should be twofold:—(1) To give shipmasters a sufficient knowledge of the meteorology of Chinese and Japanese waters to enable them at all times, and especially at critical moments, to recognise the best routes to follow in order to reach their destinations as speedily as possible, and emerge with credit from storms which they have been unable to avoid; and (2) to give vessels about to leave the port notice of the winds and weather they will probably meet during the subsequent twenty-four hours. The Siccawei Observatory will be able to accomplish both these ends, provided it receives the co-operation of the various shipmasters resorting to the coast of China. It is recommended that every vessel should be provided with a register in which at stated intervals during the day the conditions of the barometer and thermometer, the direction and force of the wind, and the quantity of rain are accurately recorded. In addition to these the various lighthouse keepers and officers at Custom stations along the coast should keep a similar register. The director of the observatory will have in these numerous observations a basis on which to work, and his investigations and the result will be made public as widely as possible.

Father Dechevrens then proceeds to describe what is already known of the meteorology of the China seas. Two kinds of storms prevail there, those from the north, which may be called the storms of winter, or the northern monsoon, and the typhoons, which are, properly speaking, storms of summer, or the southern monsoon. The first come from the interior of Asia and travel towards the North Pacific from west to east, while the second generally remain confined to the neighbourhood of the Philippines, Formosa, and the Gulf of Tonquin. In order to study these storms more effectually, the observatory should receive, twice daily, meteorological observations from Manila, Hongkong, Amoy, Tientsin, Nagasaki, and Vladivostock. By these means warnings can be rapidly conveyed to and from Shanghai of storms coming either from the north or south. The observatory at Siccawei, moreover, should be connected by telephone with the foreign concession in Shanghai, and Father Dechevrens offers the services of one of his observers for the Shanghai end of the line. The Director concludes his Report with the observation that the work will not be one of a day, for everything is yet to be done. "The meteorology of these countries must be commenced at its foundation."

The recommendations contained in this Report were all adopted by the Chamber of Commerce, the members taking on themselves all the financial and business management of the undertaking. The owners of vessels and the Chinese Customs were called upon to supply the instruments necessary for observing, which were those recommended by the Meteorological Office in London, and already in use in some British mail steamers. The agent of the Great Northern Telegraph Company has promised to transmit the daily reports free of charge, and it is anticipated that the Chinese authorities and the local underwriters will contribute the funds necessary for carrying out the project.

Taken in conjunction with the establishment of a complete observatory in Hongkong, for which, as we have already mentioned, the Colonial Government has liberally provided, the scheme above described is one of much scientific and practical importance. Although several observatories are already in existence at various parts of the China seas, no combined attempt has been made to study systematically the meteorology of these regions. The project which has now been adopted by the Shanghai Chamber of Commerce helps to bring to a focus a number of observations which, taken singly, are of small value, but when collected and examined by competent scientific men, cannot fail to produce beneficial results

THE AURORA [1]

II.

AS we have said, it was not uncommon at the *Vega's* winter quarters to see two or more auroral-arcs, one of which was generally the "common arc." The second was nearly parallel to it and separated from it by an unlighted space which was sometimes crossed by rays of light. It would be most important for a thorough knowledge of auroræ to know the true mutual position of the arcs; but here again simultaneous measurements at two distant places are necessary, and not having such, Nordenskjöld remarks that three suppositions may be made. First, that the two arcs have irregular positions with regard to one another; secondly, that they are superposed on one another, having their centres on the same axis perpendicular to the surface of the earth; and third, that their centres are on the same radius of the earth, and that they are situated in about the same plane. In all three cases the aspects of the arcs would be quite different. The observations at the *Vega's* wintering place prove that the last case is the rule, and that arcs irregularly situated with report to one another, or crossing one another (which would correspond to the first and second supposition), are exceptions; and Nordenskjöld arrives at the conclusion that the auroræ-arcs which were seen from the *Vega*, were usually in about the same plane. It might be asked, however, if it were not more natural to suppose that both rings are at the same distance from the earth's surface, their centres being situated on the same radius of the earth? But on March 14 two parallel arcs appeared, and soon joined together into a broad belt, the interior edge of which was 5°, and the exterior one was 15° above the horizon, both edges being quite concentric,

[1] A. E. Nordenskjöld, "Om norrskenen under *Vegas* öfvervintring vid Berings Sund, 1878-79," in "*Vega* Expeditionen Vetenskapliga Arbeten." (The Scientific Work of the *Vega* Expedition, part 1, pp. 401-452.) Continued from p. 321.

and the belt showing a tendency to divide into parallel bands, whilst its brilliancy remained the same towards the lower and upper edges; Nordenskjöld considers therefore as most probable that all the luminous sheet afforded by these arcs was in the same plane.

The rays which sometimes, but rarely, appeared during the arc-aurora also confirms the supposition. They were usually cast from the interior arc towards the exterior and reached its edge, but never went beyond it. On the contrary, when the aurora was intense, new rays were cast

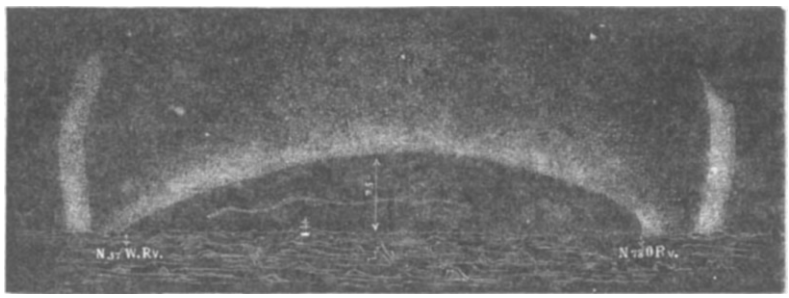

FIG. 3.—Aurora at the *Vega's* winter-quarters, March 3, 1879. at 9 p.m.

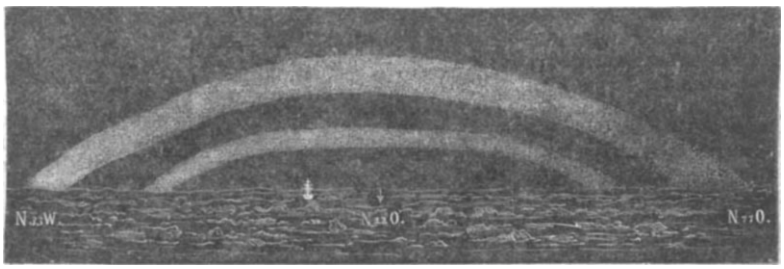

FIG. 4.—Double aurora-arcs seen on March 20, 1879, at 9.30 p.m.

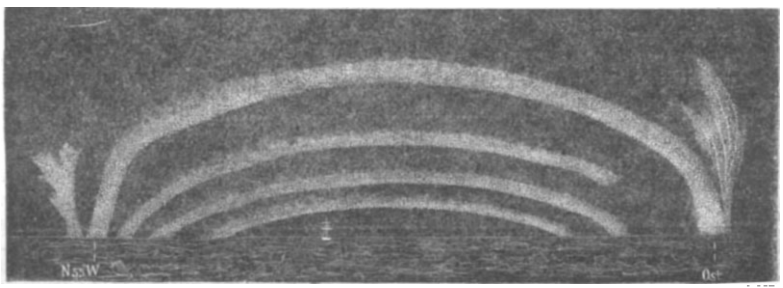

FIG. 5.—Elliptic aurora seen on March 21, 1879, at 2 15 a.m.

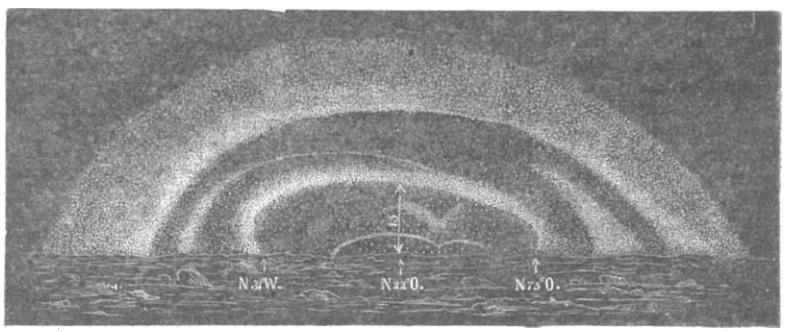

FIG. 6.—The same, at 3 a.m.

from the exterior arc, as well towards the interior one, as in the upper space. These phenomena render it most probable that these rays (which must not be confounded with those which form the draperies during strong auroræ) are in the same plane which passes through both luminous circles. If these two circles were situated in the same upper strata of our atmosphere, it would be reasonable to suppose that the rays which flow from one to

another are also in the same strata. In this case they could not be rectilinear, but must flow upon curves drawn by a radius equal to the distance from the crowns to the centre of earth; therefore, when seen from the *Vega's* winter quarters, the rays which were cast 50° or 60° from the edge of the luminous arc, would appear only exceptionally as straight lines; usually they would show a regular curvature of several degrees. But neither at Kolutchin Bay nor at other places did Nordenskjöld remark such a curvature, and he concludes that the common aurora-glory must be produced in a plane perpendicular to the earth's radius, which passes through the aurora-pole. But it is possible also that the long exterior rays may have quite another direction than those which connect together aurora-rings; and whilst these last are cast in the plane of the aurora-glory, the former may be launched in the direction of the inclination-needle.

A drapery-aurora was seen but once at the *Vega's* winter-quarters. But sometimes the common arc rose more above the horizon, or changed its bearing; or new arcs, quite different from the common one, appeared. Sometimes, as, for instance, during the night of March 3 to 4 (Fig. 3), the bows crossed one another. In general the feeble auroræ were quite regular, whilst the more intense afforded more or less irregularity. But even these latter usually began with the appearance of the common faint arc; this soon increased, divided into pieces by the appearance of brilliant knots—not divided, however, into rays—and flame-like knots maintained for a long time the same position, sometimes in the neighbourhood of the arc, but mostly in the north-eastern part of the sky, sometimes also in the zenith. From these knots were thrown flames of equally diffused light (not divided into rays), often, as it seemed, perpendicular to the plane of the glory, and in such case spreading to a very great height above the surface of the earth. The aurora of March 3 to 4 was remarkable for the number of arcs which appeared; towards 9.30 p.m. they crossed one another at their north-western extremities, but disappeared after eleven o'clock, so that at midnight only the common arc was seen. But about one o'clock another series of arcs appeared towards the west, the outer being tangential to the common arc near the horizon, much like to a double solar halo.

Another interesting aurora was seen on March 20 to 21 (Figs. 4, 5, and 6). It was remarkable by the extension and great size of the arcs, by their elliptic shape, and by the circumstance that the short axes of the ellipses were not vertical above the horizon, but inclined, sometimes to the right (Fig. 5) and sometimes to the left (Fig. 6). It seems as if the plane of the glory was slowly oscillating for some 4° or 5° on both sides of its usual position.

On March 30 to 31 there appeared a great number of arcs, which were seen all at the same time. Of six arcs, only two were in the north-eastern part of the sky, whilst the summit of the third was nearly at the zenith, at a height of 80° and three others were beyond the zenith, their summits being respectively 105°, 125°, and 135° distant from the north-eastern horizon.

It is most important to determine where, and under what aspect, the aurora-glory is visible in different parts of our globe, and Nordenskjöld gives special attention to this subject. The second (outer) ring and its rays can be seen over a very great surface of the northern hemisphere. If the rays which were seen from the *Vega* as flowing from this ring to the zenith were cast in the plane of the glory, and if they were cast from all parts of the ring, they must have been seen over a circle drawn from the aurora-pole by a radius measuring 5000 kilometres on the surface of the earth. This circle would include North America as far as California, England, France, and the northern parts of the Iberian Peninsula, Austria-Hungary, Crimea, Siberia, and Northern Sakhalin. But the rays often passed beyond the zenith of the *Vega*, and thus the region of their visibility must be still further increased, including Mexico, Spain, Morocco, Greece, Asia Minor, a part of Turkestan, and Mantchuria; that is, even such tracts where auroræ very rarely occur. But Nordenskjöld does not maintain that all auroræ observed in Europe were due to rays cast from the glory in its plane. He thinks it would be too bold an assertion, as it would mean that thousands of observers were in error as to the idea they got of the direction of rays. But it is probable that a certain part of radiant auroras observed in Europe are due to rays cast in the plane of the glory, and not to rays cast in the direction of the inclination-needle. As to the drapery-aurora which was seen once during the *Vega's* wintering, it seemed to have had its seat nearer to the surface of the earth. Such auroræ are obviously in the same relations to the common arc as the irregular winds and storms of the north are to the regular trade-winds of the south.

On the contrary, the space where the common ring of the glory is visible is very limited. Its projection on the earth's surfacce would be a circle drawn from the aurora pole by a radius of 18°, measured on the surface of our globe. And if its height above this surface is 0·03 radius of the earth, it must be seen above the horizon in a belt 14° wide on both sides of this projection. But to be observed its faint arc must have a height of at least 4° above the horizon, and so the belt of visibility of the common glory-ring is still less. Besides, if the aurora-glory is in reality a ring of light of small thickness situated 200 kilometres above the surface of our globe, it will not be visible in those parts of the earth where it appears in the zenith; there it would appear as a too faint diffused girdle of light about 60° wide, and most probably would not be perceived.

Therefore we must have five different regions situated around the aurora pole, where the glory would appear under quite different aspects. These five regions are represented on the map, Fig. 7, which is a reduction of Nordenskjöld's map.

In the first circular region around the aurora-pole (I. on our map), inscribed in a circle drawn from the aurora pole with a radius measuring 8° on the surface of the earth, the glory is visible only as a luminous mist, or as a very low bow, in a direction opposite to the aurora-pole. As the projection of rays within the common arc seems to be very rare, the aurora phenomena is very rarely to be seen in this region. Very many Arctic explorers have visited this region: Parry, Ross, McClintock, Kennedy, Osborn, Saunders, Belcher, Hayes, Kane, Hall, Stephenson, and Nares, have wintered within it; but among their careful and varied observations auroræ occupy quite an insignificant place—a circumstance very remarkable, as it is obvious that auroræ cannot be overlooked by Arctic travellers, being the only variety during the long Arctic nights. Parry saw auroræ as a feeble diffused light in the south-west; Hayes saw but three auroræ; and Capt. Nares says: "Light flashes of aurora wera occasionally seen on various bearings, but most commonly passing through the zenith. None were of sufficient brilliancy to call for notice. The phenomena may be said to have been insignificant in the extreme, and, as far as we could discover, were totally unconnected with any magnetic or electric disturbance."

The second region (II.) is inclosed between two circles drawn from the aurora pole by radii 8° and 16° long. The common ring of aurora must be seen in this region as a luminous bow, the upper part of which is situated in a bearing opposite to that of the aurora-pole, that is, about the magnetic south. Ross, Parry, McClure, Mac Clintock, Koldewey, and Nordenskjöld (1872-73) have wintered in this region. Ross, on September 23, 28, and 29, 1818, saw vertical rays in the southern part of the horizon, and Parry, on September 15, 1825, saw a bow 5° or 6° high, which lasted, nearly unchanged, for two or

three hours in the south-east. The observations of the Swedish expedition at Mussel Bay (Spitzbergen) were but very incompletely published, but they were also in accordance with the present views of Nordenskjöld. The interior circle of the bow which was seen from the *Vega*, and which was but 5° above the horizon, must be seen from Mussel Bay, close by the zenith, and therefore nearly invisible; while the exterior part of the common arc appeared as a bow of regularly spread light in the magnetic south. Rays of light were spread from it towards the interior circle, and gave rise to the beautiful draperies which so often were seen at Mussel Bay. When the aurora became still stronger, rays of light were sent out even in the interior circle, from the zenith towards the magnetic north, and then a crown appeared, whose rays seemed to meet together at the place where the inclination needle was directed.

The third region (III of the map) is situated between two circles drawn from the aurora-pole by radii 16° and 20° long. In this region the common arc must be in the zenith, and, as has already been pointed out, it must be less often seen as a bow than as a diffuse light spread upon the sky; but this light is so small in comparison with the ray-auroræ which begin in this region, that it must draw but little attention. The second interior circle of the glory must appear in this region as a bow in the magnetic south, and the common, or the interior one, as a luminous arc in the magnetic north, and both arcs must cast rays to one another through the zenith, from north to south, or *vice versâ*. The region comprises the northern parts of British America, the middle parts of Davis Strait, a part of Southern Greenland, Southern Spitzbergen, and Franz Joseph Land; Maguire, Tobiessen, and Payer wintered in this region. As is known, Weyprecht has given a very good *résumé* of the meteorological observations of the expedition, which correspond to a maximum year of auroræ. There were, during 1872-74, fifty-eight arc-auroræ, thirteen of which had the summits of their arcs

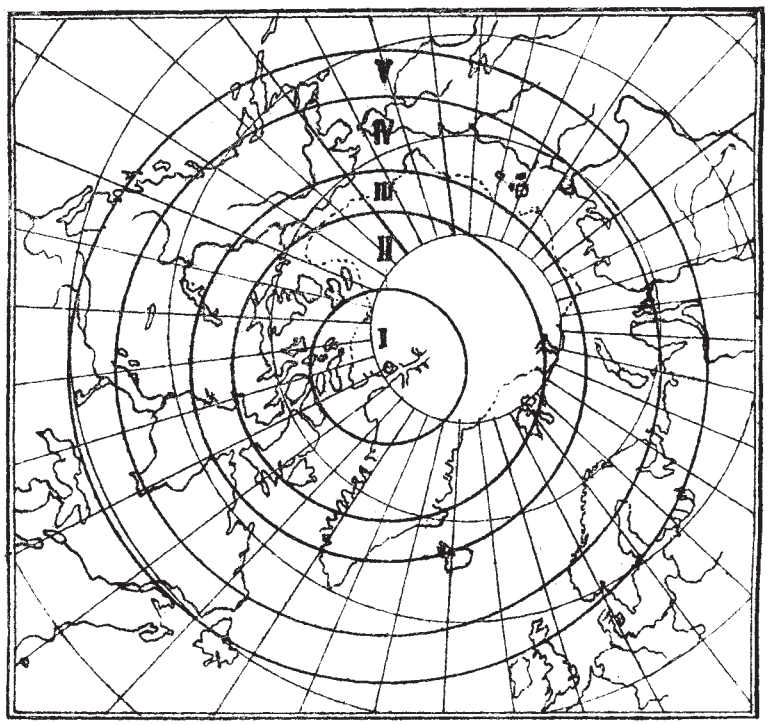

FIG. 7.—Map showing the visibility of the common aurora-glory in the northern hemisphere (reduced from Nordenskjöld's map).

in the magnetic north, and twenty-eight in the south, whilst the arcs of seventeen other auroras passed through the zenith, or communicated by rays through the zenith from north to south, or *vice versâ*. Besides, the aurora often began with a diffused light which Weyprecht has described as *Nordlichtdunst* (aurora-mist), and which spread over great parts of the sky. Weyprecht draws special attention to the arc-auroræ, and says: "Separate rays are not seen in them. The arc has but a moderate brilliancy, which is equally distributed throughout its surface. Intense auroræ never appear in the shape of arcs. The arc characterises the regular and quiet form of the phenomenon."[1]

The fourth region (IV. of Fig. 7) is a belt drawn by two radii 20° and 28° long. It passes through Northern Siberia, British America, the southern extremity of Greenland, Iceland, Northern Scandinavia, and Novaya Zemlya. In this region the auroræ usually begin with a luminous bow in the magnetic north, out of which spread radiant beams of more or less intense light, either into free space or to another ring parallel to the former, but lying higher above the earth's surface. The observations of Wrangel and Anjou, and those of the *Vega* were made in this region, as well as those made in Iceland, Southern Greenland, and in the middle parts of British America; but Nordenskjöld did not have these last at his disposal. Wrangel has given much attention to auroræ and, so far as can be judged from the incomplete information published in his "Travels" and in Parrot's account of Wrangel's physical observations, they confirm the existence of a permanent luminous ring around a certain point of the earth's surface, in the neighbourhood of the magnetic pole. During his travels on the shore east of the Lena mouth, Wrangel mostly saw bow-shaped auroræ, the summit of which was in the direction N. 12°–22° E. (true).

The fifth region (V. of our map) is inclosed between the

[1] "Die Nordlicht Beobachtungen der Österr. Ung. Arct. Exped.," in the "Denkschriften der Math.-Wiss. Classe der k. Acad. der Wiss., Wien," Bd. xxxv., 1878.

foregoing and a circle drawn around the aurora-pole by a radius 28° long. The interior circles of the glory are not seen in this region, but we see sometimes their rays and the exterior rings, less common and less regular. The quiet aurora is rare in this region, but the aurora-storms and the beautiful drapery-auroræ are most usual.

It is obvious that the frequency of auroræ must be different in the different regions represented on the map (Fig. 7). They must be most frequent in region IV., as in this we may see both the common glory and the drapery-auroræ, which arise at a greater distance from the aurora-pole, and probably nearer to the surface of the earth. Towards the north this region is bordered by a belt where auroræ must be less frequent, and which, in its turn, includes another belt of a maximum frequency of auroræ, where the arc-aurora must be most common; but the drapery-auroræ are below the horizon. In the circular region around the aurora-pole itself, even the common arc is below the horizon, and therefore auroræ must be rare. Therefore Nordenskjöld observes that his map is much like that of the frequency of auroræ published by Prof. Fritz (*Petermann's Mittheilungen*, 1874, p. 374). Besides, the visibility of auroræ depends upon the position of the sun, and Nordenskjöld observes that it seems that the aurora-arc disappears, or at least becomes invisible, as soon as the sun's rays illuminate that part of our atmosphere where the aurora-ring has its seat. Calculating on this principle a table of the hours when the aurora-arc must appear and disappear for an observer stationed at the *Vega's* winter-quarters, he finds that the disappearance of the aurora in the morning is in accordance with this supposition, whilst its appearance in the evening seems to be independent of this cause, as it used to appear about nine o'clock.

As to the relation of auroræ to terrestrial magnetism, this will be better seen when all the observations of the *Vega* are published. But Nordenskjöld remarks that the "common arc," so long as it was not transformed into more intense forms of aurora, did not exert on the magnetic needle any influence which might not have been included in the usual observations of variations. But the more intense auroræ exerted such an influence, and when the aurora was on the increase, the declination showed a small tendency to a deviation towards the west, whilst the intensity varied much: the horizontal component diminished, and the vertical one increased, especially as the auroræ approached the zenith.

Nordenskjöld tried also to make some spectral observations on auroræ, and he observed the usual greenish-yellow line, together with a bluish-grey spectrum towards the violet end. But the observations were rendered so difficult by the fearful frosts that he could not succeed in making more detailed measurements.

He concludes his most interesting memoir on auroræ with the following words:—"When writing this contribution to our knowledge of the position of auroræ in space, I had at my disposal but few former works on this subject. I must especially regret that our very rich library of travel did not contain the works of Mairans, Bravais, Fritz, Loomis, &c. After returning home I discovered that a method of determining the height of auroræ similar to mine was proposed by Fr. Chr. Mayer (Comment. Acad. Scient. Petropolitanæ, part 1, p. 351, St. Petersburg, 1728), and applied, among others, by Torbern Bergman (*Kgl. Vet. Akad. Handlingar*, xxv., Stockholm, 1764, pp. 193 and 249; xxvii. 1766, p. 224). But Bergman arrived at uncorrect figures, as he supposed that the centre of the aurora ring is situated on the radius of the earth which passes through the pole. Besides, he had no observations upon the *common arc*, and had only measurements of the larger, less regular arcs which are seen from more southern regions. Knowing how little time remains for personal investigation to one who returns from a long exploration in unknown tracts, I have preferred to publish at least a general account of the most important features of the observations I made at the *Vega's* winter-quarters than to postpone the publication for an indefinite time. The want of a larger perusal of former literature upon the subject will probably be excused to some extent by the circumstance that, when writing this, I had the opportunity of continuously comparing the sketch I have tried to draw with the natural phenomena themselves." P. K.

NOTES

THE second ascent of Ben Nevis for the winter was made on Saturday last by Mr. Livingstone, Fort William, to read the thermometer at the station of the Scottish Meteorological Society on the top of the mountain. The depth of snow was found to be much greater at the top than on the occasion of the previous visit. On the edge of the precipices the snow lay to a depth of fifteen to twenty feet, the Ordnance Survey Cairn barely overtopping it, and the hut built for the accommodation of Mr. Wragge during summer being almost completely buried under the snow-wreaths. The depth of the snow rapidly diminished in the direction of the protecting-cage for the thermometers, outside which it was only three feet deep. Inside the cage, fortunately, there was scarcely any snow, thus leaving the registering thermometers free. The maximum thermometer read 32°·1, and the minimum 13°·2, these being the extremes of temperature at the top since the date of the previous visit on December 3 (NATURE, vol. xxv. p. 135). The temperature at the time of the visit, 1 p.m., was 31°·4 in the cage, and by *thermomètre froid*, 33°·1. The spring near the summit was deeply buried in snow, but the spring at 2500 feet high was open, and the temperature of its water was 37°·3, the air at the same place being 41°·0. The temperature of the water of the Lake was 42°·1, and that of the air at the same height 44°·8. At Fort William the maximum temperature for the same day was 53°·5, and the minimum in December 23°·5, and in January 26°·8. Hence the temperature at the top had fallen only about 10°·0 lower than the lowest at the level of the sea during the winter. The day was very favourable for the ascent, which was made without difficulty. Though it had rained heavily at Fort William on the Friday, no fresh snow had fallen on the Ben, and as the afternoon sun softened the snow somewhat, the descent was very easy, the first 2000 feet being done in thirty-three minutes. The observations made on these two occasions show that as the snow accumulates to such great depths near the edge of the precipice, the observatory it is proposed to erect should be built at some distance from it.

THE death is announced, on February 8, of Prof. Joseph Decaisne, the eminent naturalist, at the age of seventy-five years.

WE regret to announce the death of Adam von Burg, vice-president of the Vienna Academy; he died on February 1, aged eighty-five. He was well-known by his mathematical and mechanical papers, especially by his "Compendium der höheren Mathematik" and "Compendium populæren Mechanik und Maschinenlehre."

LET us remind our readers that in connection with Captain Abney's lectures there is an interesting Exhibition of Photographic Apparatus and Appliances at the Society of Arts, of which a Catalogue has been issued. The exhibition will be open till February 25 from 10 to 4, and on Wednesday evenings from 6 to 10. Any one interested in photography may obtain admission by applying to the Secretary of the Society of Arts. To-night there will be a demonstration of photography with artificial lights likely to be of great interest.